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## Moored Rainfall Measurements During COARE

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This presentation discusses mini-ORG rainfall estimates collected from an array of six moorings in the western equatorial Pacific during the TOGA-COARE experiment (Figure 1). The moorings were clustered in the vicinity of the COARE Intensive Flux Array (IFA) centered near 2°S, 156°E. The basic data set consisted of hourly means computed from 5-second samples.

The TOGA-COARE Intensive Observing Period (IOP) took place from November 1992 to February 1993, during the El Niño/Southern Oscillation (ENSO) warm event of 1991-93. Rainfall accumulation for the period September 1992 to March 1993 overlapping the COARE IOP was 2589 mm from the moored mini-ORG array, more than 2.5 times larger than Morrissey and Greene's (1991) climatological estimate of 902 mm for the same months based on atoll data. Anomalously high rainfall in 1992-93 is consistent with enhanced deep convection in the region during ENSO events; and with the incidence of high rainfall accumulations in western Pacific atoll records in previous ENSO years (Ropelewski and Halpert, 1987).

The horizontal correlation structure for rainrate based on the moored ORG data was estimated for different temporal averaging intervals of 1 hour, 1 day, 5 days and 10 days (Figure 2). Space lags ranged from 1.5 degrees (166 km) to 11 degrees (1221 km). Spatial correlation increased with temporal averaging interval, from near zero for hourly data at all horizontal separations, to 0.6-0.8 for 10-day averages. Correlations were generally highest at shorter spatial separation, though significantly non-zero correlation was found for 5-day and 10-day averages even over 11 degrees separation.

The moored ORG data at 0°, 156°E, 0°, 157.5°E and 2°S, 156°E were averaged to 5-day pentads for comparison with 1) the GOES Precipitation Index (GPI) for the 2.5° by 2.5° square centered at 1.25°S, 156.25°E (Arkin and Ardanuy, 1989); 2) a 4-channel microwave SSM/I rain product for the 2.5° by 2.5° square centered at 1.25°S, 156.25°E (Berg and Chase, 1992; provided courtesy of Wesley Berg, University of Colorado); and 3) a preliminary analysis of Omegasonde data at 0000Z from the COARE IFA (provided courtesy of Dick Johnson and Xin Lin, Colorado State University). The 4 estimates (Figure 3) are all highly correlated. However, there are significant amplitude differences between them (Table 1). Some of the difference may be due to an overestimate of mini-ORG determined rainrate by O(10%) as suggested by preliminary ORG calibrations in high rainrate. The GPI, on the other hand, probably reads low because it does not detect "warm rain" falling from clouds whose cloud tops are above the GPI algorithm threshold of 235 K. The SSM/I may read low because the 15-70 km spatial resolution of the microwave sensor channels is coarse relative to the 10 km dimension of individual rain cells (Chang et al, 1993). The Omegasonde estimates may read low relative to the moored

estimates because the former apply to a much larger area (roughly 1°N-4°S, 151°E to 158°E). Regression offsets (B in Table 1) imply that the satellite and sounding estimates indicate rain when the buoy averages read zero; these offsets probably result from the different areal coverage of the buoys and the other rainrate estimators. This interpretation is supported by regression between the spatially coincident GPI-SSM/I time series, for which there is only 1 mm offset. Despite these differences (which can be rationalized in terms of the different sampling techniques and areal coverages), the results are very encouraging in that the time evolution of rainfall in the vicinity of the COARE IFA based on 4 completely independent estimates agrees so well. All 4 estimates, for example, show evidence of rainfall variability associated with the passage of 60-day Madden and Julian oscillations.

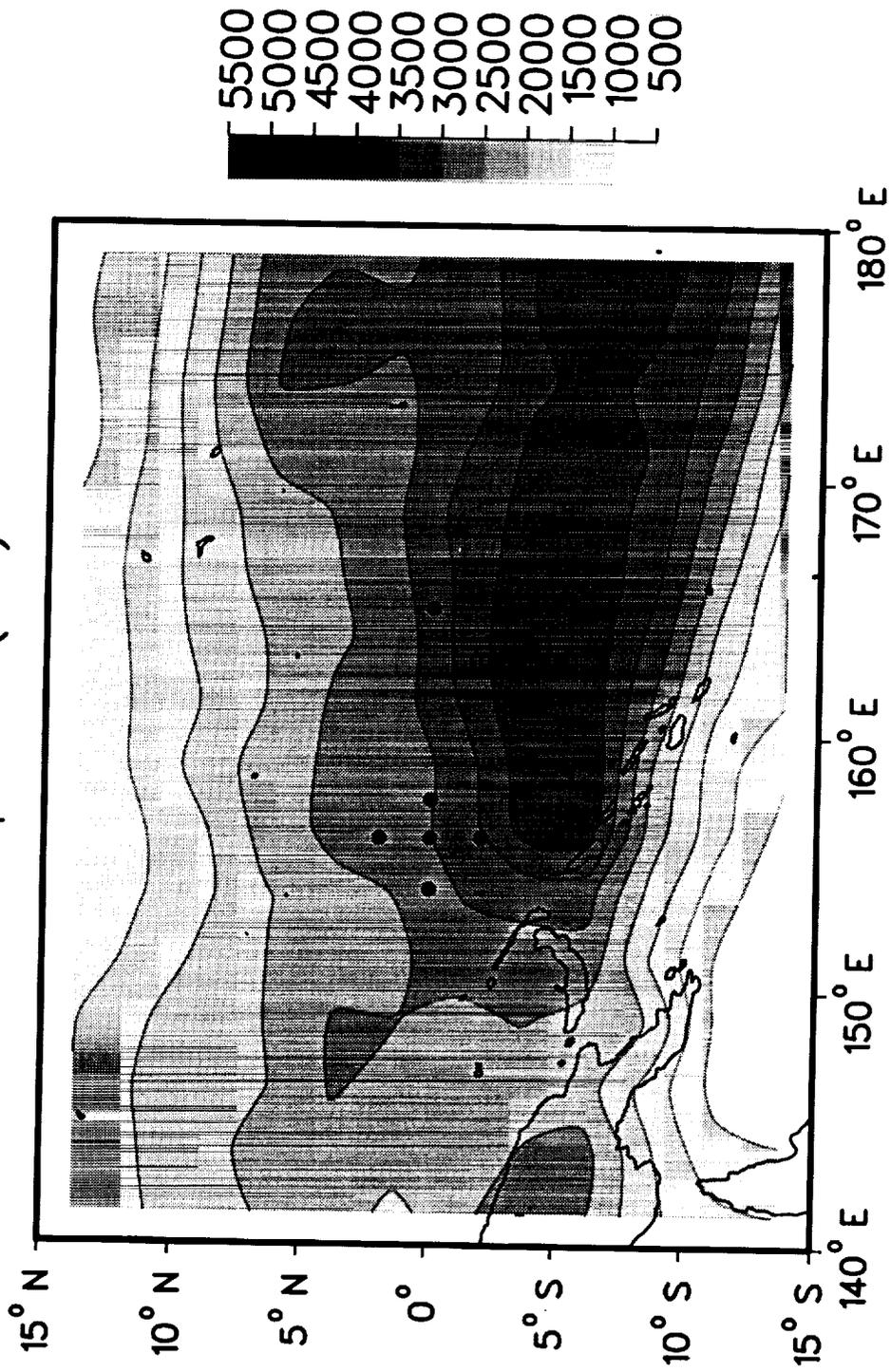
Table 1. Statistics of regression analysis for pentad rainfall accumulations (in mm) in the vicinity of the COARE IFA. Regression formula is given by  $Y=A*X+B$ , where X are the mini-ORG estimates, and Y is either GPI, SSM/I and atmospheric sounding based estimates of rainfall. N is the number of pentads used in the regression analysis

	Xcorr	A	B	N
GPI-ORG	0.77	0.51	20.6	51
SSM/I-ORG	0.77	0.41	4.8	24
Sounding-ORG	0.74	0.21	27.2	20

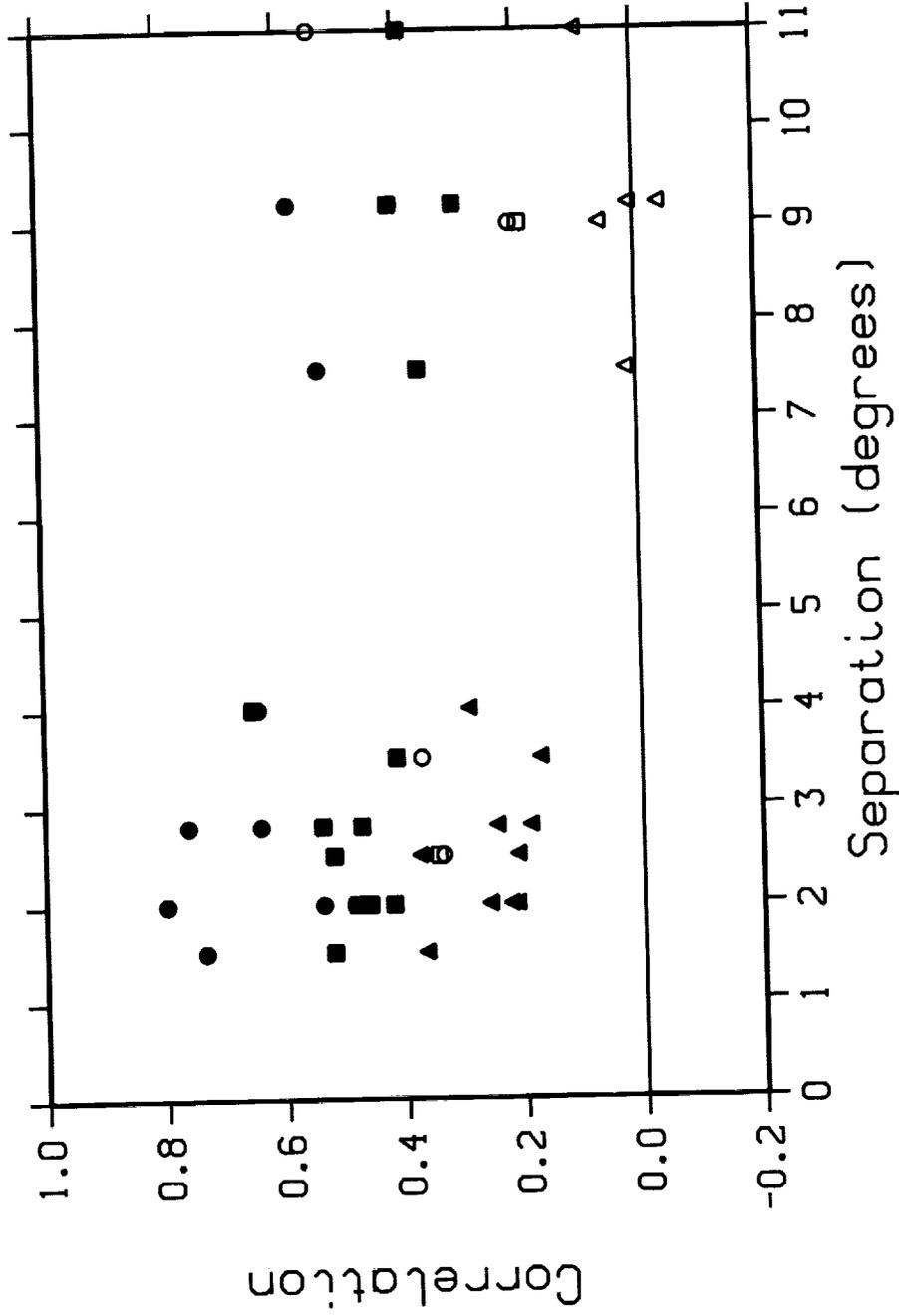
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1 Jan 92 - 31 Dec 92  
Precipitation (mm)



Rain gauge values  
2°S-2°N, 154°E-165°E



● 10-day  
 ■ 5-day  
 ▲ 1-day

Solid - Significant at 95% Level  
 Open - Not significant at 95% Level

